



## ***Chapter 15. Bringing More Meaning to Weather Predicting: the Weather Station and “Reading” the Sky Help Put It All Together: A Guided or Open-Inquiry Activity***

### ***Background***

This publication uses the building of weather instruments as a means of developing a better knowledge of the basic elements of meteorology related to understanding and ultimately predicting weather. In addition, much effort was expended to produce these activities that vary in level of inquiry. In this section, there is an emphasis on other important attributes of learning.

Some of the instruments needed for a weather station are described simply and directly. The approach does not abandon the important learning involved in building and applying various types of weather instruments. However, there are challenges given for developing or securing more accurate and sophisticated instruments. Because of the importance of technology and the wealth of information available from the Internet, guidance is given for searching the Internet and enhancing the classroom activities by using this important learning medium (Appendix V). Emphasis in this section focuses on the necessary skills of keen observation, the ability to collect important data and using this data in projecting outcomes. Finally, the important and basic information about air movements should coalesce as this information relates to the formation of clouds and their movements in bringing our future weather.

The following information focuses on the tools, procedures, and the necessary understanding to build a backyard weather station. Most immediately, the instructions, as they relate to the elements of a weather station, are more directed and of low-level inquiry. The approach becomes much less directed and moves toward guided and open inquiry as it stresses proper ways of collecting data, compiling

and synthesizing data from the weather station, and ultimately relating this data to changes in sky condition.

The learners might choose to use some of the instruments they have constructed and to purchase others as needed, such as (1) an anemometer, (2) a wind vane, (3) a rain gauge and (4) a thermometer from a local hardware store or scientific supply house. Also, instructions are given to construct these needed instruments if desired. It might be interesting to compare the accuracy of the data collected from the student-constructed instruments with the data from the more sophisticated purchased ones and to check the results.

### ***Building a Simple Weather Station***

A weather station, as shown in Figure 15-1, consists of a series of instruments that can be used to collect information about weather factors such as temperature, air pressure, rainfall, relative humidity, wind direction and wind speed. Ideally, these instruments should be grouped as closely together as possible. The instruments of an official weather station are often sheltered in an enclosure, except for the anemometer and rain gauge.

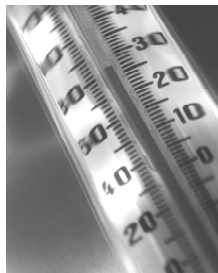


**Figure 15-1.**  
**A weather station.**

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## Instruments Needed

A **thermometer** is needed to measure the air temperature. It is important to make sure that the bulb of the thermometer is shielded from the direct sunlight.



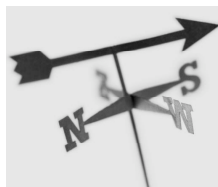
A **rain gauge** is needed to measure the amount of precipitation. A rain gauge should be placed in an area where it is well exposed to an open sky and not sheltered by trees or other overhanging obstructions.



A **barometer** is needed to measure the air pressure.



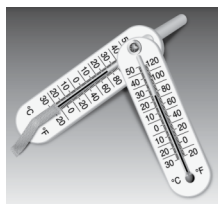
A **wind/weather vane** is used to determine wind direction. The wind vane should be placed in an open area where it can rotate freely as the wind direction changes.



An **anemometer** is used to measure wind speed. An anemometer should be placed in an open area where it can rotate freely as the wind changes direction and speed.



A **psychrometer/hygrometer** is used to measure relative humidity. If a hygrometer is used, make sure that it is shielded from exposure to direct sun.



It is important to decide which weather events and data you want to record and how often you want to take measurements, such as once a day, twice a day and so forth. The more detailed and accurate your measurements and recordings are, the more specific your picture of the patterns will become.

## Extensions for This Activity

Many kinds of open-inquiry activities can be established using the weather station:

Listening to and recording the seven-day TV weather forecast can be used to compare your predictions based upon your weather station output.

Long-range comparisons can be made by keeping an accurate record of your data over a long span of time.

Comparisons with the almanac readings (simply averages over long spans of time) can be compared with your long-range recordings to determine how they correlate.

Compare the percent accuracy of your weather station data predictions with that of the TV weather predictions to see how they correlate.

The following are directed instructions for ways to construct weather instruments not addressed in the previous sections of this publication.

The following activities or directions assist the learners in devising the additional weather instruments they will need but have not yet developed.

### Weather Vane or Wind Vane

A weather vane (also called a wind vane) spins on a rod and points in the direction *from* which the wind comes and is used for determining wind direction. It is probably one of the oldest weather tools and is usually shaped like an arrow. One end is shaped like an arrowhead and turns into the wind, and the opposite end is wide so that it is affected by the slightest breeze.



## ***Weather Vane Materials***

Cardboard (or plastic for weatherproofing for outside use)

Paper and pencil

Scissors

Plastic drinking straw

Clear tape

Plastic soft drink bottle

Shallow metal pan

Glue

Felt marking pen

Rocks for weight

Compass



## ***Procedure for Constructing a Weather Vane***

With scissors, carefully cut out of the cardboard or plastic an arrow with a tab that is slightly narrower than the inside diameter of the neck of the bottle (2 cm (0.75 in.)). Tape one end of the straw to the tab. Bend the tab slightly so that the arrow turns more easily.

Remove the rocks from the center of the pan and glue the bottom of the soft drink bottle to the middle of the pan and allow the glue to dry.

After the glue has dried, insert the other end of the straw into the neck of the bottle and place the rocks in the pan for weight (Figure 15-2).

Use the compass to find north, and then mark the four sides of the pan N, E, S, and W with the felt pen.

Test the functioning of the weather vane by placing it outside and observing the results to determine how

well it functions. Test it on a windy day and again when there is just a slight breeze.



**Figure 15-2. Completed weather vane.**

## ***Simple Anemometer***

### ***Materials***

Five 85-ml (3-oz) plastic cups

Two plastic soda straws

One pencil (with unused eraser)

Single-hole paper punch

Thumbtack or pushpin

Permanent magic marker

Stopwatch or wristwatch  
with a second hand



## ***Simple Anemometer***

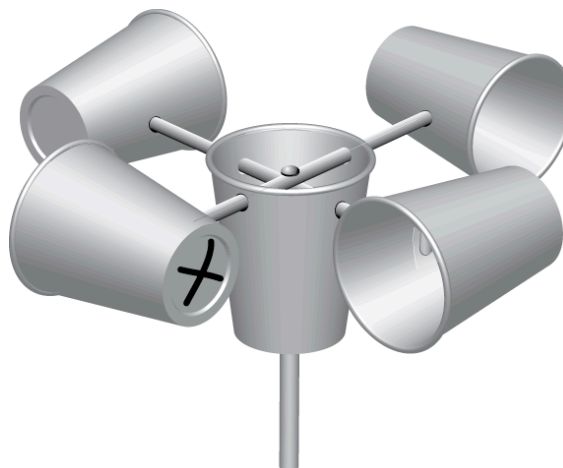
An anemometer is a device used to determine wind speed. Cups or fins that are activated by the wind are placed around a rotating axis. This causes the axis to rotate at different speeds as the wind increases and decreases. Perhaps the anemometer is the most difficult weather instrument to build accurately. However, the principles upon which an anemometer is based can be shown by the construction of this simple one.

### ***Procedure for Constructing a Simple Anemometer***

Punch one hole about 1.5 cm (0.5 in.) below the rim of each of four plastic cups. Punch two holes in the fifth cup directly opposite from each other, about 1.5 cm (0.5 in.) below the rim. Next, punch two more holes in this cup, each .75 cm (0.25 in.) below the rim and making sure that these holes are equally spaced between the first two holes.

Using the pushpin and the scissors, carefully make a hole in the bottom center of the cup that has the four holes. Ensure that this newly created hole is large enough for the pencil to easily fit through.

Next, slide one of the straws through one of the one-hole cups. Bend the end of the straw that is inside the cup about 1.5 cm (0.5 in.) from its end and tape it to the inside of the cup. Place the other end of the straw through the two holes in the four-hole cup. Bend and tape (as you did earlier) this end of the straw to the inside of another one-hole cup, making sure that the openings of the cups are pointing in opposite directions. Next, complete this same procedure for the remaining two one-hole cups. Make sure that the opening of each cup faces the bottom of the one next to it. No two openings should face each other. The completed anemometer should look like the one in Figure 15-3.



**Figure 15-3. Completed anemometer.**

Using the permanent magic marker draw a large X on the bottom of one of the one-hole paper cups.

The anemometer is now ready for testing. If the wind is blowing, take it outside to an open area. If there is no wind, place it in front of a small fan that is turned to a low setting. Position yourself so that you can see the X on the bottom of the cup as it spins around. Count the number of revolutions in 10 seconds. Use Table 15-1 on this page to estimate the wind speed. See Appendix VIII for the Beaufort Scale of Wind Speed.

**Table 15-1. Estimated Wind Speed**

| <b>Revolutions<br/>in 10 seconds</b> | <b>Wind Speed<br/>in kilometers<br/>per hour<br/>(km/h)</b> | <b>Wind Speed<br/>in miles per<br/>hour (mph)</b> |
|--------------------------------------|---|---|
| 2-4                                  | 2   | 1   |
| 5-7                                  | 3   | 2   |
| 8-9                                  | 5   | 3   |
| 10-12                                | 6   | 4   |
| 13-15                                | 8   | 5   |
| 16-18                                | 10  | 6   |
| 19-21                                | 11  | 7   |
| 22-23                                | 13  | 8   |
| 24-26                                | 14  | 9   |
| 27-29                                | 16  | 10  |
| 30-32                                | 18  | 11  |
| 33-35                                | 19  | 12  |
| 36-37                                | 21  | 13  |
| 38-40                                | 23  | 14  |
| 41-43                                | 24  | 15  |
| 44-46                                | 26  | 16  |
| 47-49                                | 27  | 17  |
| 50-51                                | 29  | 18  |
| 52-54                                | 31  | 19  |
| 55-57                                | 32  | 20  |

## ***Pitfalls***

The importance of this anemometer construction activity is to understand the operating principles of an anemometer. This anemometer is not designed to measure very accurate wind speeds. However, the more carefully this simple anemometer is constructed, the more accurate will be the readings of wind speeds. It should be kept in mind that there may be some problems in getting accurate counts of the rotation of the cup as well. The numbers in the chart are used to convert the rotation to wind speed. These are rough approximations.

## ***Extensions of This Activity***

If a more sophisticated anemometer can be secured, comparisons can be made between wind speeds obtained by the simple and more sophisticated anemometers.

The learner can be challenged to make modifications in the simple anemometer to improve on the accuracy of the wind speeds that are obtained.

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## Rain Gauge

A simple rain gauge can be made from a straight-sided container made of plastic, glass or metal. It is necessary to have a method of measuring the amount of precipitation that is collected in the container. Therefore, a clear plastic or glass container might be preferred because it can be marked off and labeled on the outside of the container. If the weather is below freezing, it will be necessary to measure and empty these types of containers before they freeze and break. A metal container has the advantage of not breaking when ice forms, but measuring the amount of precipitation becomes more of a challenge.



When small amounts of precipitation fall, the amount collected can be difficult to measure. Specially designed range gauges with larger openings (not straight sided) have been designed and calibrated to meet this challenge. Because rain gauges are relatively inexpensive and can be purchased at local hardware stores, it might be wise to purchase this device for your weather station. The rain gauge is an essential part of the backyard weather station.

## Sling Psychrometer

A sling psychrometer's major components are two thermometers. One is a dry-bulb thermometer and the other is a wet-bulb thermometer. A water-soaked piece of cloth placed securely over the bulb end of one of the thermometers converts a dry-bulb to a wet-bulb thermometer. Using a 6-inch wooden dowel, a wood screw and a hole in the upper end of each of the thermometers, the thermometers can be attached so that they can be twirled. See page 48 for detailed directions for constructing a sling psychrometer.

